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Title: MONITORING AND ENHANCING PLANT PRODUCTIVITY

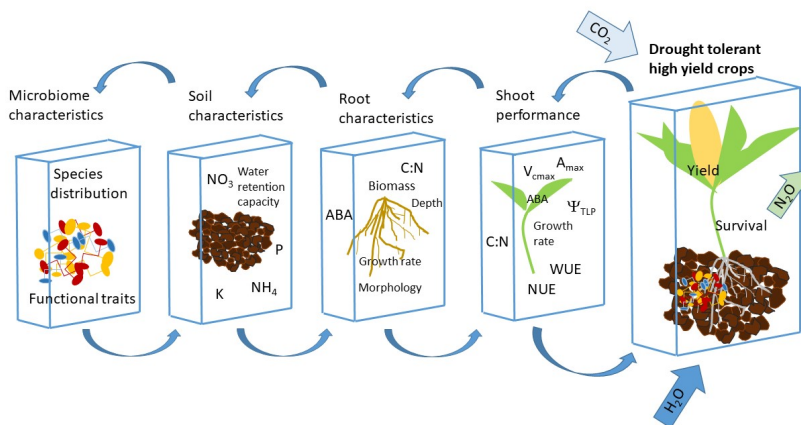
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Tech Snapshot Earth and Environmental

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MONITORING AND ENHANCING PLANT PRODUCTIVITY

Improving plant drought tolerance, water and nutrient use efficiency and reducing greenhouse gas emissions from agriculture and natural systems



SUMMARY

Researchers at Los Alamos National Laboratory are developing extensive capabilities to improve plant drought tolerance; water and nutrient use efficiency and reduce greenhouse gas emissions from agriculture and natural systems. By monitoring plant function, stress responses, water and nutrient use, greenhouse gas emissions, and analyzing rhizosphere and plant microbiomes, results have shown improved plant performance and stress tolerance, production of plant pro- and prebiotics, and ability to control greenhouse gas emissions from indoor and outdoor agricultural systems. We seek a commercialization partner to fund precision agriculture specific research & development (R&D) through a Cooperative Research and Development Agreement (CRADA). Our goal is to further research and develop our laboratory scale capabilities with a collaborative partner to achieve two goals: 1) reduce the use of water and fertilization in agricultural systems; and 2) create carbon neutral food and energy technologies to support precision agriculture at commercial scale.

BENEFITS

Our capabilities in monitoring and enhancing plant productivity.

- In situ monitoring of plant performance, and greenhouse gas production and uptake of agricultural systems
- Accurate measurements and understanding of plant carbon, water and nutrient uptake for enhanced performance predictability
- Enhanced remote sensing and other fast detection methods for quick phenotyping
- System-level analyses of plant-soil-microbiome interactions using data science techniques such as machine learning
- Engineered pre- and probiotics to enhance plant productivity and nutrient and water use efficiency

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MARKET APPLICATION

The precision farming market is the primary market opportunity with a focus on traditional and vertical agriculture in greenhouse and outdoor settings. In 2020, the vertical agriculture target market valued at ~\$4 billion. An essential element of precision farming is the intense focus on observation, measurement and responses to variability in crops, fields and animals. Our unique scientific methods and capabilities at the laboratory scale to optimize plant carbon uptake, measure plant productivity, nutrient, and water use and monitoring greenhouse gas emissions may provide a competitive advantage when implemented at

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significantly reduce the cost and increase the profits of food and biofuel production for large-scale greenhouses. Agricultural producers while limiting their environmental impact.

WHY WE ARE BUILDING MONITORING AND ENHANCING PLANT PRODUCTIVITY

Currently, we have internal research and development funds to further develop our scientific methods and explore new observational techniques and technology that may have a direct positive impact on large-scale greenhouse productivity and profitability. Our goal is to further research and develop our laboratory scale capabilities with a collaborative partner to achieve two goals: 1) reduce the use of water and fertilization in agricultural systems; and 2) create carbon neutral food and energy technologies to support precision agriculture at commercial scale. To achieve our goals, we plan to optimize microbiomes associated with plant roots to improve plant performance and allow adaptation of these technologies to different agricultural settings and target crops and different soils or growing media.



WHAT'S BEHIND OUR TECHNOLOGY

Los Alamos has incorporated inputs from years of research and development, and experience in environmental sciences and monitoring, plant physiology and microbial ecology to offer a means for optimizing agricultural systems and plant performance. The combination of our unique laboratory scale methodologies in: 1) enhanced remote sensing and other fast detection methods for quick phenotyping; 2) system-level analyses of plant-soil-microbiome interactions using machine learning; and 3) engineered pre- and probiotics may provide a prospective collaborative partner with unique competitive advantages when applied at the commercial scale. Once fully developed, these technologies may provide means to develop practices and protocols to minimize plant resource use, maximize productivity and nutrient density, reduce greenhouse gas emissions, and increase profits.



OUR COMPETITIVE ADVANTAGES

Our capabilities have the potential to provide a competitive advantage with our combinatorial approach to address three distinct challenges in precision farming: 1) enhanced monitoring; 2) system-level analyses of plant-soil-microbiome; and 3) engineered pre- and probiotics to enhance plant productivity through optimal nutrient and water use. Our combinatorial approach is well suited to be scaled up from the laboratory scale to commercial field scale application.



OUR TECHNOLOGY STATUS

Los Alamos capabilities in plant functional measurements and environmental monitoring are well established at the laboratory bench scale. We are seeking a commercialization partner to further develop our methodologies in fast plant phenotyping and microbiome optimization, apply, and adapt them to field scale commercial application. Although we have a conceptual model for scale up of our methodologies, funding from a commercialization partner through a Cooperative Research and Development Agreement is necessary to convert concepts to commercially viable technologies that allow for testing under a number of different environmental conditions.



PUBLICATIONS AND IP

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